Perceived Impact of Climate Change on Swamp Rice Cultivation by Farmers in Ebonyi State, Southeastern Nigeria

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Original Research Article

ABSTRACT

The perception of changes in climate in any environment by farmers significantly influences their ability to adjust and cope with challenges that might emerge from such changes. Climate change can have direct impact on swamp rice cultivation because swamp rice cultivation in Ebonyi State is rain-fed. This impact is particularly significant as swamp rice farming constitutes a major source of income and employment in the area. The study thus examined the perceived impact of climate change on swamp rice cultivation by farmers in Ebonyi State, Southeastern Nigeria and compare with meteorological data. Data used for the study were obtained through the administration of 505 copies of structured questionnaire to swamp rice farmers in the three agricultural zones of the State. Also, data on rainfall and temperature were sourced from the archive of Nigerian Meteorological Agency, Oshodi, Lagos covering a period of 31 years. Primary data obtained were analysed using descriptive statistics. Results showed that 82.6% of the respondents were aware of climate change;

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81.8% claimed to have noticed change in climate in the last two decades; 50.9% of the farmers have noticed an increase in farm size. However, 79.0% of the respondents were of the view that change in rainfall is responsible for the increase noticed in farm size. Climatic trends show a positive trend and the 2-year moving average suggests an increase in temperature and rainfall over the 31 years. Climatic trends confirmed farmers' perceptions that temperature and rainfall are increasing. Overall impacts of climate change on swamp rice cultivation appear to be positive as farmer's perception of climate change is consistent with meteorological data. With increasing swamp size in the area as a result of increased rainfall, it becomes compelling that wealthy individuals, corporate bodies and government should direct more investments to swamp rice farming in Ebonyi State in order to boost food security, employment and consequently income generation for the area and Nigeria in general.

1. INTRODUCTION

All over the world issues related to climate change have become a major concern especially as it relates to agriculture. This is because climate change is seen to be causing serious challenges to the development of agriculture, food security and the general livelihood condition of man [1]. Farming activities especially those dependent on rainfed, rely on favourable climate conditions to be productive and are at risk under a changing climate [2], especially if it comes with adverse conditions. Basically, climate is described as the average weather over a defined time period from 30 to 35 years. Weather on the other hand, deals with the state of the atmosphere above a given place at a specific time. The two are mutually exclusive events and affect agricultural activities in a number of ways which can either be positive or negative. While climate change can be said to be a marked departure from an initial climate due to a sustained trend in any climatic element over a long period of time not less than 30 years. Changes in climate can occur naturally or can be induced by some activities of man.

However, the present change in climate is majorly attributed to man's activities in the environment arising from the release of greenhouse gases with carbon dioxide being the chief greenhouse gas. Carbon dioxide (CO_2) is present naturally in the atmosphere as part of the Earth's carbon cycle (the natural circulation of carbon among the atmosphere, oceans, soil, plants, and animals). Human activities are however altering the carbon cycle by the addition of more CO_2 to the atmosphere as a result of industrial activities embarked upon by man and also by influencing the ability of natural sinks, like forests, to remove CO_2 from the atmosphere. Carbon dioxide emission can come from a variety of natural sources; but human-related emissions are responsible for the increase that has occurred in the atmosphere since the inception of the industrial revolution. As climate is caused to change, several other components of the environment are also affected by these changes which could be negative changes or positive changes. Some of the negative effect of these changes witness in the last few decades is the increase in incidences of droughts which are becoming more frequent and prolonged all over the world. This is because as the planet warms, rainfall pattern tends to shift, and extreme event such as droughts, famine, flood, and forest fire becomes more frequent and pronounces [3]. An extension of these changes in climate could result in drying-up and/or shrinking of water bodies including swamps in some region. On the other hand, its positive impact could result in form of increased rainfall which could result in the enlargement of these water bodies in other regions [4-7]. As these changes occur in the swampland rice cultivation could be encouraged especially in areas like Ebonyi State were rice farming is dependent on rainfed due to increases in farmland made available by increasing rainfall. In Nigeria, swampland constitutes an important ecology for agriculture [8]. This is because it helps to bridge the gap created by the limitation of upland production system, and by so doing provides sustainable crop production for the growing population [9]. In Nigeria, some states are endowed with swamp lands. Ebonyi State is one of such states and is popular for the cultivation of swamp rice. It is a very important agricultural State in the cultivation of swamp rice as more than 50% of the total Nigerian output of rice is produced in the State [10].

Rice is an important food crop in Nigeria. It has attained a staple food status as it has become a major source of calories intake for many [11].

Even the world over, rice is one of the most common staple foods for humans; it feeds more people than any other crop [12]. It implies that any adverse impact on swamp size due to climate change particularly rainfall will likely affect a greater population of Ebonyi State and those in Nigeria that largely depends on swampland for the cultivation of rice as source of livelihood. Alternatively an increase in this swampland resulting from an increase in rainfall due to climate change will be of great benefits as more swampland will be available for swamp rice cultivation thereby boosting food cultivation and generally income generation. Several studies in Nigeria, have shown that most crop farming is rain-fed, hence rainfall is the most important element of climate [13,14], as a change could largely affect its farming. Researches have shown that without adequate awareness, issues of mitigation and adaptation to climate change will remain a big challenge which will be detrimental to the environment as a whole and the agricultural sector in particular, and that it is only through knowledge and awareness that the vulnerability of the environment can be largely reduced [15-18]. Therefore, to achieve sustainable swamp rice cultivation in Nigeria, an in depth study of farmers perception and changes in the trend of climate element particularly rainfall is necessary. Hence, this paper compares the perception of swamp rice farmers with meteorological data so as to assess the association between them for a better planning scheme to improve swamp rice cultivation amidst climate change.

2. MATERIALS AND METHODS

2.1 Study Area

The study area Ebonyi State, shown in Fig. 1, is located in South-eastern part of Nigeria which lies approximately within latitudes 5° 40' and 6° 45' North and longitudes 7°30' and 8°30' East. The area is characterized by bimodal rainfall pattern [19]. The rainy season is from April to October, while the dry season begins from October through February. The wet season has its first peak in July and the second occurs in September, the area records annual rainfall of between 1613.8mm to 2136.27mm [20] the dry season starts in November, when the dry continental North-eastern wind blows from the Mediterranean Sea across the Sahara desert and Samarian desert and down to the southern part of Nigeria. About 60-70% of the inhabitants of Southeast zone are observed to engage in agriculture mainly crop farming [21].

Ebonyi State is divided into three agricultural zones. These agricultural zones are Ebonyi North, Ebonyi Central and Ebonyi South. The State has a landmass of approximately 5,935 square kilometres. It has boundary on the East with Cross River State, Benue State on the north and Enugu State on the west and Abia
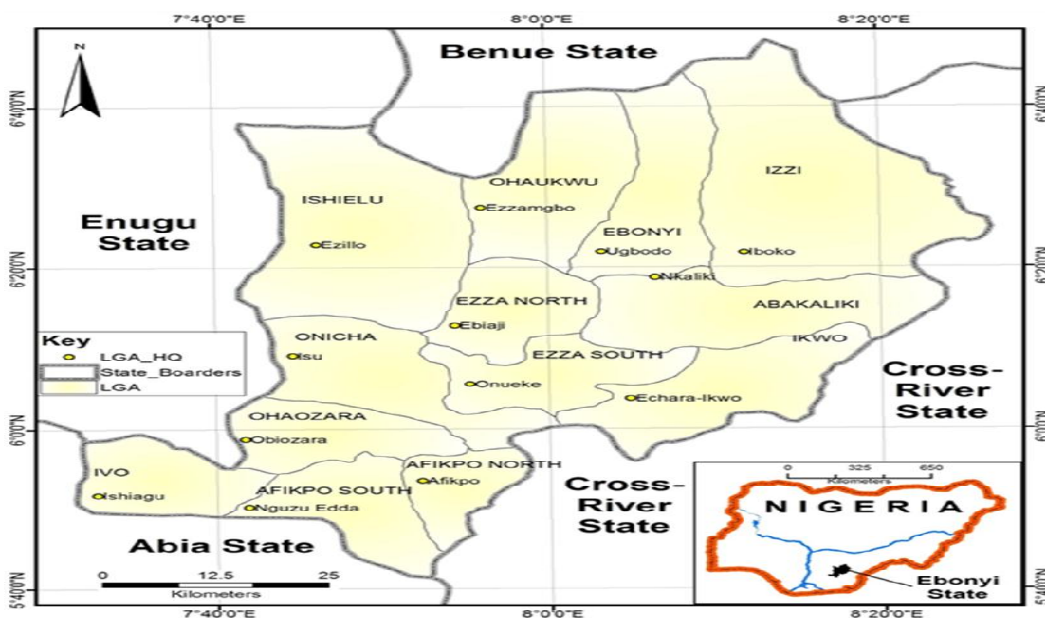

Fig. 1. The study area: Ebonyi State, Southeastern Nigeria

State on the south [22]. Ebonyi State has a population of 2.1 million [23]. It is one of the Southeastern States of Nigeria that is endowed with vast area of swampland and is popular for the cultivation of swamp rice. Ebonyi State produces more than 50% of the total Nigerian output of rice. Rice is commonly produced in lowland /swamp lands. Ebonyi State has two major types of soil. The soil has a texture of clayey, loamy and has a poor drain which has gravel subsoil in some places especially the upland areas which is close to the lowland areas [24]. The clayey swampy soil found in the State makes the area suitable for rice farming.

2.2 Method of Data Collection

The study used primary and secondary data. Primary data were collected from swamp rice farmers which included socio-economic characteristics of swamp rice farmer, awareness of climate change, access to information on climate variables, sources of information on climate variables, time of noticing these changes in climate variables, changes in farm size, factors responsible for these changes, types of changes, when these changes were noticed, and effects of these changes on swamp rice cultivation and compared with climate data. The research was conducted in the three agricultural zones of Ebonyi State namely Ebonyi North, Ebonyi Central and Ebonyi South. In the study area, there are fifty -two (52) groups of swamp rice farmers which make up a total of 995 registered swamp rice farmers in the State as obtained from Agricultural Development Programme (ADP), Ebonyi State in 2015. The 995 registered swamp rice farmers spread across the three agricultural zones which formed the population of the study. The farmers in the list in each zone were numbered serially and those that fall on the odd numbers (1, 3, 5, 7…) were administered with the questionnaire. The study used the simplified formula for sampling provided by Yamane in 1967 [25] to identify the appropriate total respondents in each zone. The formula is presented as

$$n = \frac{N}{1+N}(e)^2 \qquad (1)$$

Where,

  e =Deviation of sampling,
  N=Population size and

n=Sample size

This formula is reliable at 95% and less than 5% variation factor [25]. This resulted to using 505 copies of structured population. Descriptive statistics was employed to summarize the socio- economic characteristic of the swamp rice farmers and response of the farmers on climate change. Information obtained from the administered questionnaire was analyzed using tables, frequency and percentage.

Also, temperature and rainfall data were sourced from the archives of the Nigerian Meteorological Agency, Oshodi, Lagos for a period of 31 years, 1984 to 2015. The data were meant to determine the trend in climate of the study area. Temperature and rainfall are indicators of climate change [26].

2.3 Method of Data Analysis

Descriptive statistics was applied in summarizing the socio- economic characteristic of the swamp rice farmers and response of the farmers on climate change .Information obtained from the administered questionnaire was analyzed by using tables, frequency and percentage. While the least squares regression is used in the study to model the trends in temperature and rainfall data over the 31 years period. The result from the least square regression helps to determine the overall average rates of change in trends of annual temperature and rainfall in the study area.

The equation for least square regression is

$$y \quad = a \ + \ bx \qquad (2)$$

Where

$$b \quad = \quad \frac{n\sum xy - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2} \qquad (3)$$

And

$$a \quad = \quad \frac{\sum y}{n} - \frac{b\sum x}{n} \quad = \quad \bar{y} - b\bar{x} \qquad (4)$$

a is the intercept; b the regression coefficient or slope;
y =the temperature/rainfall values (dependent variable);
x =the time in years ;(independent variable)
x̄ = the mean time; and
ȳ = the mean temperature/rainfall value.

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of Swamp Rice Farmers in Ebonyi State, Nigeria

In the sampled population showed in Table 1, 41.0% respondents were aged between 30- 40 years, 30.5% were aged between 40-50 years, while 19.2% were aged between 50- 60 and 9.3% were aged 60 years and above. Majority of the farmers were between 30 and 50 years, which suggest that they were able-bodied farmers who were in their reproductive years. This result is contrary to the general belief in Nigeria that due to migration from the rural areas to the cities, farming is left for only the elderly. This may also not be unconnected to the current rate of unemployment in the country as a lot of youths have resorted to farming instead of waiting for white collar jobs. Males in the sampled population were 73.7% while females were 26.3%. It revealed that there are more males involved in swamp rice cultivation than females. Also, over 60% of the rice farmers had a minimum of first school leaving

Table 1. Socio-economic characteristics of respondents (n=505)

Age (Years)	Frequency	Percentage (%)
30-40	207	41.0
40-50	154	30.5
50-60	97	19.2
60 and above	47	9.3
Sex		
Male	372	73.7
Female	133	26.3
Educational qualification		
First school leaving	133	26.3
O' level	209	41.2
NCE	66	13.1
OND	61	12.1
HND	17	3.4
BSC	8	1.6
Other degrees	11	2.2
Average household yearly income from swamp rice farming		
Less than 100k	42	8.3
100-200k	85	16.8
201-300k	106	21.0
301-400k	62	12.3
401-500k	50	9.9
501-600k	54	10.7
601-700k	21	4.2
701-800k	27	5.3
801-900k	31	6.1
1 million and above	27	5.3
Membership of cooperative union		
Yes	336	66.5
No	169	33.5
Years of cultivating swamp rice		
1-5	34	6.7
6-10	63	12.5
11-15	96	19.0
16-20	95	18.8
21-25	95	18.8
26-30	63	12.5
31-35	33	6.5
36-40	26	5.1

Source: Authors' fieldwork, 2016.

certificate. This shows that they were fairly educated; with the implication that they have got the ability to effect desirable changes in attitude, skills and knowledge [27].

About 8.3% of the sampled population earns an average of less than 100 thousand Naira from swamp rice cultivation per year,16.8% earns between 100-200 thousand Naira, 21.0% earns between 201-300 thousand Naira,12.3% receives between 301-400 thousand Naira, 9.9% receives between 401-500 thousand Naira, 10.7% receives between 501-600 thousand Naira, 4.2% receives between 601-700 thousand naira, 5.3% receives between 701-800 thousand naira 6.1% earns between 801-900 thousand and 5.3% earns from 1 million and above. The study revealed that over 50% of the farmers earn below 500 thousand naira yearly. Also about 66.5% of the sampled population belongs to farmers' cooperative union while 33.5% are not members of any cooperative union. This shows that majority of the swamp rice farmers are actively involved in the cooperative groups.

On the years involved in swamp rice farming a fair proportion 6.7% of the sampled population have been involved in swamp rice farming for between 1-5 years,12.5% for between 6-10 years,19.0% between 11-15 years, 18.8% between 16-20 years, another 18.8% 21-25 years, 12.5% 26-30 years while 6.5% between 31-35% and 5.1% between 36-40 years. More than 60% of the farmers had cultivated swamp rice in the study area minimum of 11 years. This invariably might have helped them to have adequate knowledge of changes being experienced in climate. The result agrees with that Shetty, who reported that more farming experience improves awareness of potential benefits and willingness to participate in local natural resource management and conservation activities [28].

3.2 Farmers' Awareness of Climate Change

Analysis on the awareness of climate change among the swamp rice farmers in the study area shows that 82.6% of total respondents were aware of climate change while 17.4% were not aware of it (Table 2). It implies that the majority of the farmers in the sampled population were fully aware of changes in climate. It was discovered that 85.9% of total respondents had information on climate variables (temperature

and rainfall) while 14.1% claimed of having no opportunity to receive information on the climate variables (Table 2). However, the sources of information on temperature and rainfall were received from agricultural extension officers by 20.2% of total respondents while 36.2% got such information from television, 40.8% from radio and 2.8% from newspaper (Table 2). This means that adequate information on climate variables is available in the study area. In Table 2, 81.8% of the sampled population have noticed/perceived changes in temperature and rainfall pattern while 18.2% have not noticed changes in them. Table 2 also signifies that 67.5% of swamp rice farmers have noticed an increase in temperature, while 14.3% have noticed a decrease in temperature. Temperature remains unchanged for 18.2% of the sampled farmers. While the table also indicates that 40.8% of the farmers have noticed a decline in total yearly rainfall, 39.2% noticed an increase in total yearly rainfall while total yearly rainfall remained unchanged for 20% of the farmers.

3.3 Impact of Climate Change on Swamp Rice Farm

Table 3 shows that 68.7% of sampled farmers have noticed changes in the size of their swamp rice farms while 31.3% of the farmers have not noticed changes in it. In the table, 50.9% of the swamp rice farmers have noticed an increase in their farm size, 19.0% noticed a decrease, and farm size has remained unchanged for 30.1% of the farmers. This increase in farm size could be due to the increase in rainfall noticed by 40.1% of the farmers. About 79% of swamp rice farmers (Table 3) believed that climate change is responsible for the changes in the sizes of their swamp rice farm while 21% believe climate change is not responsible for the changes. However, 42.5% of the farmers noticed this change in the last 5 years, 32.3% in the last 6-10, 23.5% 11-15 while 1.7% noticed it between 16-20 years ago (Table 3).

Table 3 also reveals that 76.2% of the farmers are of the view that the change in farm size has affected the cultivation of swamp rice positively while 23.8% says it has not affected cultivation of swamp rice. This increase in swamp size perceived by majority of the farmers which is largely attributed to climate change is a good indication for better rice farming towards achieving food security. Hence, farmers have taken this advantage provided by climate change to increase the number of times rice is planted in

Table 2. Awareness of climate change (n=505)

Awareness of climate change	Frequency	Percentage (%)
Yes	417	82.6
No	88	17.4
Access to Information on Temperature and Rainfall		
Yes	434	85.9
No	71	14.1
Sources of Information on Temperature and Rainfall		
Agricultural Extension Officer	102	20.2
Television	183	36.2
Radio	206	40.8
Newspaper	14	2.8
Notice of Changes in rainfall and temperature changes over the last 20 years		
Yes	413	81.8
No	92	18.2
Temperature changes		
Increase	341	67.5
Decrease	72	14.3
No change/The same	92	18.2
Do not know	-	-
Rainfall changes		
Increase	206	40.8
Decrease	198	39.2
No change/The same	101	20
Do not know	-	-

Source: Authors' fieldwork, 2016.

Table 3. Changes in farm size (n=505)

Changes in Farm size	Frequency	Percentage (%)
Yes	347	68.7
No	158	31.3
Types of changes		
Increase	257	50.9
Decrease	96	19.0
No change	152	30.1
Notice due to climate change		
Yes	279	79.0
No	74	21.0
Number of years of noticing changes in farm size due to Climate change		
0-5	150	42.5
6-10	114	32.3
11-15	83	23.5
16-20	6	1.7
Positive effects of farm size changes on Cultivation		
Yes	269	76.2
No	84	23.8

Source: Authors' fieldwork, 2016

a year, thereby increasing income generation, creating employment and boosting the economy of the state.

3.4 Trends in Temperature and Rainfall Data

The analysis of the annual temperature data of the study area using regression analysis revealed an upward trend in the data (Fig. 2). The least square equation showed that the annual temperature is increasing at the rate of 0.0037℃ per annum. This is in line with the general global trend [29]. Though this looks little, it implies much for any location in the tropics where temperature is relatively high. The finding conforms to the perception of farmers on the rise in temperature in the study area.
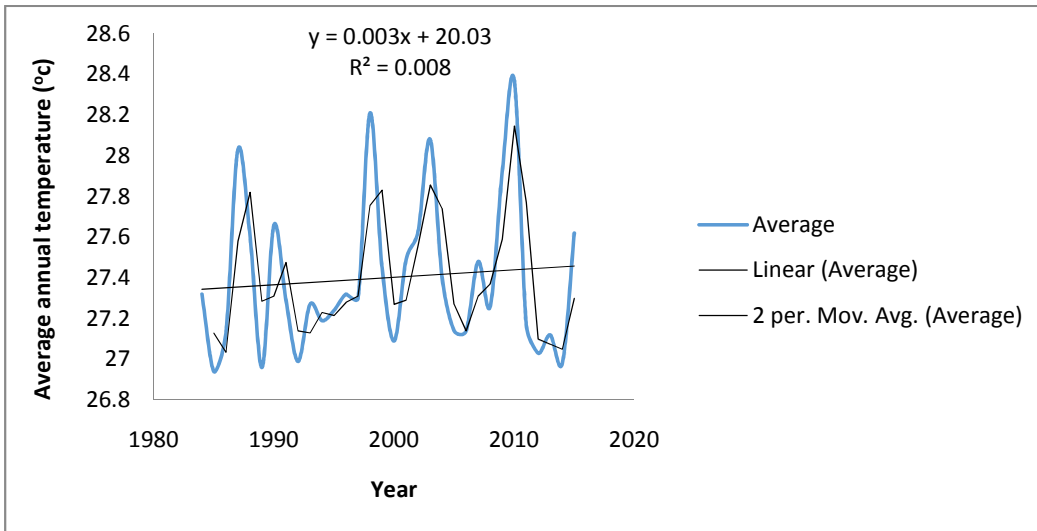
Fig. 2. Trend of annual temperature over Ebonyi State
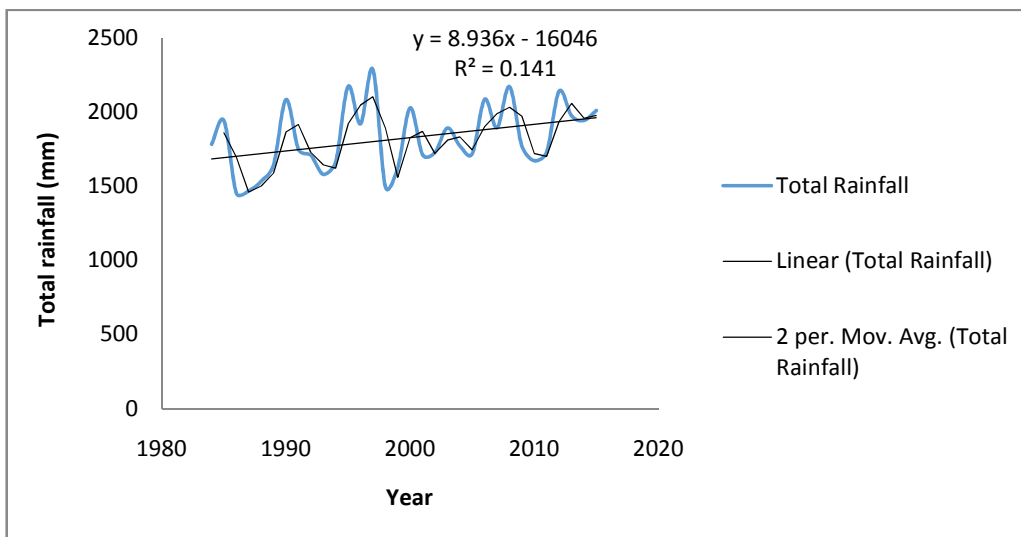

Fig. 3. Trend of annual rainfall totals over Ebonyi State

In Fig. 3, the least square line possesses an upward trend. This implies that the annual rainfall totals of Ebonyi State are increasing. It is doing so at a rate of 8.9367 mm annually. This trend is in agreement with the perception of swamp rice farmers in the study area with regard to increasing rainfall. This also proves that Ebonyi State is one of those areas in the world where rainfall is increasing, as we have some other areas in the world where rainfall is reducing [26].

4. CONCLUSION

Farmers in Ebonyi State are dominated by swamp rice farmers. The study elicited farmers'
perception of climate change; change in temperature and rainfall; changes in farm size and impact on rice cultivation. The results indicated that most farmers have noticed increases in swamp sizes implying more land available for swamp rice cultivation. The increases were attributed to climate change by majority of the rice farmers resulting from increases in rainfall in recent times as compared to previous years. The study established the evidence of climate variability/change in the study area by using meteorological data, over the past 31 years. The results indicated that swamp rice farmers have noticed changes in climate. Most of the farmers observed changes in

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temperature and rainfall patterns and in the frequent extreme events which they said had impacts on swamp land and consequently on its cultivation. The perceived changes in temperature and rainfall are highest in the last 20 years. This could mean good times for the swamp rice farmers as swamps may increase in sizes with increasing supply of rain water.

Based on these findings, it is recommended that though majority of the farmers are informed about climate change, more enlightenment campaigns still need to be carried out to enable them, corporate bodies and governments benefit from the emerging opportunities created by climate change especially with the increasing sizes of the swamps. And also to educate the farmers that are not yet aware of climate change by building the capacity of the extension workers through training and re-training programmes so as to make more climate education schemes readily available to the farmers. This will strengthen food security, create employment and boost income generation not only for Ebonyi State but Nigeria in general.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/24935